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Definition Study into the
Requirements of a Data Modem for the
SYSCOM Network

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classification

title : unclassified
abstract : unclassified
report : unclassified

no. of copies : 26
no. of pages : 41
appendices : -

date : May 1990

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report no. : FEL-90-A116
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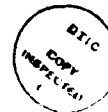
author(s) : P.P. Copeland
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date : May 1990
NDRO no. : A87KL072
no. in pow '90 : 711
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ABSTRACT (UNCLASSIFIED)

This document describes the functional requirements that need to be implemented in the development of a 'Data Modem' in support of the SYSCOM project. The Modem shall be capable of supporting the transmission of data over the RNLA's mobile tactical communications network (i.e. ZODIAC), which operates in accordance with the requirements of EUROCOM Tactical Communications Systems (D/1).

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rapport no. : FEL-90-A116
titel : Definition Study into the Requirements of a Data Modem
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auteur(s) : P.P. Copeland
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datum : mei 1990
hdo-opdr.no. : A87KL072
no. in iwp '90 : 711
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SAMENVATTING (ONGERUBICEERD)

Dit rapport beschrijft de functionele eisen die geïmplementeerd moeten worden in de ontwikkeling van een Data Modem ter ondersteuning van het SYSCOM project. Het Modem zal in staat zijn om de data communicatie over het mobiele tactische netwerk van het RNLA (ZODIAC) te ondersteunen, in overeenstemming met de EUROCOM Tactical Communications Systems (D/1) standaarden.

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LIST OF ABBREVIATIONS

ATS	Automatic Telegraphy System
CCA	Call Characteristics Acknowledgement
CCITT	Consultative Committee for International Telegraph and Telephone
CDSL	Connect Data Set to Line
CFI	Call Fail Indication
CPC	Cyclically Permutable Codewords
CRN	Call Request with Number
CRS	Call Request Special
CSA	Call Subscriber Answers
CTS	Clear to Send
DBT	Digitaal Beveiligd Toestel
DCD	Data Carrier Detected
DCE	Data Circuit-Terminating Equipment
DEBKL	Directie Economisch Beheer Koninklijke Landmacht
DMI	Data Mode Identifier
DMKL	Directie Materieel Koninklijke Landmacht
DSR	Data Set Ready
DTE	Data Terminal Equipment
DTR	Data Terminal Ready
EOH	Electrical On-Hook
FEC	Forward Error Correction
FEL	Fysisch en Elektronisch Laboratorium
GSTN	General Switched Telephone Network
INC	Incoming Call
ITA5	International Alphabet No.5
INV	Invalid
LMD	Loop Mode Designator
ms	milli-seconds
MSMV	Multiple Sampling and Majority Voting
PE	Pre-Emption

RD	Received Data
RI	Ring Indicator
RNLA	Royal Netherlands Army
RTS	Request to Send
SCRA	Single Channel Radio Access
SI	Status Indicator
SUB	Subscriber
SYSCOM	System Control and Management
TD	Transmitted Data
TE	Traffic Enable
TEA	Traffic Enable Acknowledgement
TNO	de Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek
VAL	Valid

Within the scope of data communication facilities for the Royal Netherlands Army (RNLA) there is a requirement for a study into the provision of a Data Modem, so as to provide data only transmission capabilities for the System Control and Management, (SYSCOM) system over the RNLA's mobile tactical communications network, (ZODIAC).

This definition document contains the results of that study, it details the functional requirements necessary for implementation in the development of the Modem. These requirements are primarily based on the recommendations of EUROCOM Tactical Communications, Basic Parameters (D/1) specification (Ref. 1), for the network transmission requirements and the CCITT Recommendation series for the Terminal to Modem requirements, both with amendments or enhancements so as to provide the facilities required by the RNLA.

The requirements considered necessary in the development of the Data Modem have been, for clarity, printed in bold type in the main text of this document. They are also listed, with paragraph references, in Chapter 6 of this report.

Keywords: Translating, (16)

2 FUNCTIONAL REQUIREMENTS OF THE MODEM

This section shall detail the functional requirements necessary in the implementation of the Data Modem for the SYSCOM network. The primary functional requirements of the Data Modem for SYSCOM are as follows:

- i) There shall be two versions of the Modem, an asynchronous model operating over the range 300 - 2400 baud and a synchronous model operating at 9.6 kbit/s.
- ii) The Modem versions shall provide the necessary interface and signalling conversions between that of the Data Terminal Equipment, (DTE), and the network, (i.e. ZODIAC).
- iii) The Modem versions shall be housed as a 'stand alone' equipment, (i.e. remote from the DTE), and provide the facility for remote dialling over the DTE to Modem interface.

The defined operational implementation of the above functional requirements are to be found in the following specifications, EUROCOM (D/1) and the CCITT Recommendation Series. The following paragraphs shall detail the recommended operational implementations required, with modifications if necessary based on the above specifications, so as to meet the service requirements of the RNLA for the SYSCOM network.

2.1 SYSCOM Modem Type

The EUROCOM (D/1) specification defines and permits the use of two types of modem, namely 'Type A' and 'Type B'. The operation of the modem types are described below:

The Type A modem is capable of supporting one DTE and it signals to the Switch the DATA mode characteristics (i.e. data bit rate and class) of the call by using DATA Mode Identifiers, (DMI). The DMI is then used by the Switch in the connection request message, where on receipt at the terminating Switch, it is checked for DATA mode compatibility with the

called modem. If the DMI is compatible then it is passed on to the called modem, (See Figure 2.1a).

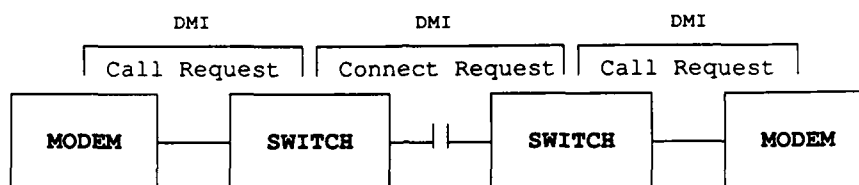


Fig. 2.1a: Type A Modem Operation

The Type B modem is capable of supporting upto four DTEs independently via four independent ports. The DATA mode characteristics of a call are signalled by using Loop Mode Designators (LMD) where the LMD corresponds to a particular DTE connected to one of the four ports. The Switch, on receipt of the LMD, translates it into a DMI which corresponds to the DATA mode characteristics of that particular DTE in accordance with a pre-defined recorded translation table stored in the Switch. The DMI is then used in the connection request message as with the Type A modem. If the called modem is also of the Type B however, then the terminating Switch in this case re-translates the DMI into the compatible corresponding LMD which is then passed on to the called modem, (See Figure 2.1b).

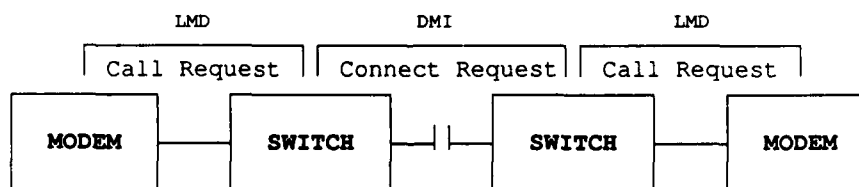


Fig. 2.1b: Type B Modem Operation

Both the DMI and LMD consist of two digits as specified in EUROCOM (D/1) Chapter IA7 Table 1 and it is possible for the LMD/DMI and DMI/LMD translation to be different for each Type B modem. **It is the Type A modem that shall be implemented as the requirement for the development of the Modem for the SYSCOM, for the following reasons, (Req. 1).**

- i) The SYSCOM requirement is for a Modem to provide single user support, this is achieved with the Type A modem.
- ii) The Type B modem, although it supports four DTE's, provides no more data transmission carrying capabilities than the Type A, as only one DTE is able to connect to the network at any one time.

2.2 Mode and Precedence Digit Implementation

Due to the requirement that the dialling facility shall be achieved remotely over the DTE to Modem interface the Modem shall be implemented such that it is required that; **the dialled number received by the Modem from the DTE shall conform to the Directory signalling format, as defined in EUROCOM (D/1) Chapter IA7, this means that it shall also contain the Mode and Precedence digits, (Req. 2).** This requirement shall result in the Modem being transparent to the Mode and Precedence digit both in the transmission and reception states. In the reception state, this shall mean that the Modem shall accept all received calls, regardless whether the Mode and Precedence digits are compatible with the operating state of the attached DTE. The responsibility for rejecting an incompatible call shall now end with the terminating Switch.

2.3 Modem Interface Requirements

The two interface requirements of the Modem, are as specified in EUROCOM (D/1) Chapter IA9, and are designated 'J' and 'K'. The J interface defines the requirements between the DTE and the Modem and K the

interface between the Modem and the network. Within EUROCOM (D/1) there are two variants of the K interface, namely K and K¹, where K applies to a static modem and K¹ to a mobile modem, (See Figures 2.3a and b). This report shall only deal with the K interface, as the K¹ interface is yet to be specified in EUROCOM (D/1) and is not required in the SYSCOM system.

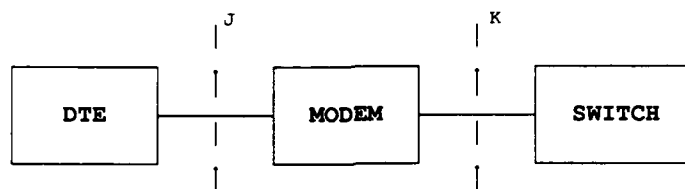


Fig. 2.3a: Static Modem Interface

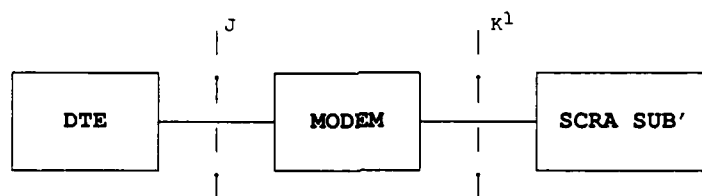


Fig. 2.3b: Mobile Modem Interface

2.3.1 Interface J

EUROCOM (D/1) states that the J interface shall be compatible with the Consultative Committee for International Telegraph and Telephone, (CCITT), V. and X. Series Recommendations, [Refs 2 and 3]. The functional characteristics of the interchange circuits shall be in accordance with CCITT Recommendations V.24 and X.21 and the corresponding electrical characteristics shall be in accordance with CCITT Recommendations V.10 and V.11. Both the above functional and electrical characteristic recommendations are still under study within

EUROCOM (D/1). The Modem shall implement CCITT Recommendation V.24 however, for the electrical characteristics the Modem shall implement CCITT Recommendation V.28 for the following reason: (Req. 3).

- i) The majority of current commercially available data communication equipments, (e.g. PC's, fax's and telex's), support a V.24/V.28 interface and not X.21, V10 and V11.

The V.24 physical interface shall consist of a 25 way D type connector conforming to ISO 2110, with support for the interchange circuits shown below. The operation of this interchange circuits during the data transfer phase shall be as defined in CCITT Recommendation V.24. During the data transfer phase the Modem shall be transparent to the data format being used over this interface, except that the mode, (i.e. asynchronous or synchronous), and the bit rate shall be the same as that used in the remote dialling phase, (See Chapters 3 and 4). The Modem shall not support asynchronous data with a format consisting of $1\frac{1}{2}$ Stop Bits, as this cannot be supported by the 'Majority Voting' section of the Class 2 MSMV process.

Interchange Circuit No.	Interchange Circuit Name	Connector Pin Number
103	Transmit Data	2
104	Receive Data	3
105	Request to Send	4
106	Clear to Send	5
107	Data Set Ready	6
102	Signal Ground	7
109	Data Carrier Detect	8
114	Tx Element Timing	15
115	Rx Element Timing	17
108	Data Terminal Ready	20
125	Ring Indicator	22

The data classification and characteristics that need to be supported between the DTE and the Modem, over this J interface, are detailed in Para. 2.4 of this report.

2.3.2 Remote Dialling Facility

The provision for remote dialling over the J interface is not a defined facility in EUROCOM (D/1), however such facilities are defined in the CCITT V series recommendations. **The remote dialling facility shall be based on the implementation of CCITT Recommendation V.25 bis, Automatic Calling And/Or Answering Equipment On The General Switched Telephone Network, (GSTN), Using The 100-Series Interchange Circuits, as modified and defined in Chapter 3 and 4 of this report, (Req. 4).** This facility shall be supported by both the asynchronous and synchronous Modem versions.

2.3.3 Interface K

The K interface is defined in EUROCOM (D/1) Chapter ID4, with reference to Chapter ID2 with respect to bit rate and clock synchronisation. These Chapters specify that the K interface shall support a 16 kbit/s or 32 kbit/s, 2-wire or 4-wire connection using Conditioned Diphase coding over full duplexed balanced wire pairs.

To provide compatibility with the ZODIAC network and the DBT, the Modem shall implement a 16 kbit/s, 2-wire connection facility at the K interface, (Req. 5). Although EUROCOM (D/1) also supports a 32 kbit/s interface, as can the DBT, this is an 'Interim' requirement and therefore the Modem shall not support such an interface. **The Modem shall perform the Loop signalling over the K interface by use of the Cyclically Permutable Codewords (CPC) as defined in EUROCOM (D/1) Chapter ID3, Table 1, (Req. 6).**

In addition the Modem shall only support the following connection facilities over the K interface as detailed in EUROCOM (D/1) Chapter ID3, (Req. 7).

- i) Basic Connection Set-up, (inc. 'Inboeken' and 'Uitboeken')
- ii) Release
- iii) Pre-emption
- iv) Switched Hot-Line
- v) Sole User
- vi) Test

To enable the Modem to be compatible and operate with a DBT it shall implement additional CPC signalling to that specified in EUROCOM (D/1) as defined in the Digitaal Beveiligd Telefoonstelsel TA-5912 Basisonderhoud document, [Ref. 4], to establish the connection facilities above, with exception of the Sole User facility which is defined in Para. 4.9 of this report. The remaining connection facilities defined in EUROCOM (D/1), as listed below, are considered not applicable to this requirement.

- i) Call -Hold, -Forward, -Transfer
- ii) Conference, Conference Add on and Broadcast
- iii) Change of Mode
- iv) Cancel
- v) Pending Call
- vi) Amend Compressed Dial List

2.4 Data Classification and Characteristics

The Modem shall be required to support two types of DTE at its J interface, each type supporting a different set of data bit rates, structure, (i.e. Anisochronous or Isochronous) and phase relationship with the network (i.e. Asynchronous or Synchronous). The following paragraphs detail the specified data bit rates, classification and class application that the Modem shall support and process at the J interface, in order to meet the requirements of the K interface, as contained in EUROCOM (D/1) Chapter IA9, to provide the system requirements of SYSCOM

2.4.1 Data Bit Rates

EUROCOM (D/1) specifies several data bit rates dependant on the type of DTE being supported as defined Chapter IA7 Table 1. Some bit rates are recommended as preferred 'Interim' or 'Ultimate' solutions for implementation as shown in Table 2.4a, the others are optional. To meet the requirements of the SYSCOM network, the Modem shall support the data bit rates as shown in Table 2.4b, which depend more on the data structure being supported by the DTE and not the type, (Req. 8).

	Tele'y kbit/s	Fax kbit/s	Data kbit/s
Interim	0.05	2.4	2.4
Ultimate	2.4	2.4	2.4
or		16.0	9.6

Table 2.4a: EUROCOM (D/1) Data Bit Rates

Structure	Data Bit Rate kbit/s
Anisochronous (Asynchronous)	300, 600, 1.2, 2.4
Isochronous (Synchronous)	9.6

Table 2.4b: SYSCOM Modem Data Bit Rates

2.4.2 Data Classification

Within EUROCOM (D/1) data is classified into four classes, as shown in Table 2.4c. Each class defines the type of structure supported at the J interface and the data processing the Modem needs to support, along with the required phase relationship with the Network to meet the requirements of the K interface.

Class	Structure	Phase Relationship	Process
1	Isochronous	Synchronous	None
2	Anisochronous	Asynchronous	MSMV
3	Isochronous	Asynchronous/ Synchronous	MSMV&R
4	Isochronous	Synchronous	FEC

MSMV(&R):- Multiple Sampling Majority Voting (and Regeneration)

FEC:- Forward Error Correction

Table 2.4c: Data Classes

2.4.3 Data Class Application

EUROCOM (D/1) also specifies which of the data classes detailed in Table 2.4c shall be implemented by the Modem with respect to the DTE type and bit rate being supported at the J interface. Table 2.4d shows the required data class applications that shall be implemented in the Modem, in accordance with EUROCOM (D/1) Chapter IA9, based on the bit rate requirements detailed in Para. 2.4.1, (Req. 9).

Class	Bit Rate kbit/s
2	300, 600, 1.2, 2.4
4	9.6

Table 2.4d: Data Class Application

The implementation of the data classes, as detailed in Table 2.4c, within the Modem versions shall be permanently fixed, internal to the Modem. This means that the asynchronous Modem shall only implement data class 2, although it shall be possible to alter the data bit rate being supported, and the synchronous Modem shall only support data class 4 at 9.6 kbit/s.

2.5 Modem Additional Requirements

The previous paragraphs of this report have specified the recommended operational implementations that need to be supported by the Modem so that it meets the requirements of the SYSCOM network in accordance primarily with EUROCOM (D/1) and the CCITT Recommendations. The following paragraphs defines the additional requirements to be supported by the Modems which are not specified in EUROCOM (D/1) or the CCITT Recommendations.

2.5.1 Modem Housing

Both Modem types, asynchronous and synchronous, shall be assembled in a 'stand alone' housing remote from the DTE. The housing shall contain two Modems of the same type which shall operate independently, with each Modem having its own independent power supply operating from a source voltage of 24V DC. The two Modem housing shall be based on the 19 inch racking system of 3U or 6U in height. The exact mechanical size of the housing is yet to be fully specified. Further environmental

specifications for the Modem are also yet to be specified.

2.5.2 Visual Indicators

It shall be a requirement of both Modem versions that they support visual indications to the User so as to indicate the operational state of each of the enclosed Modems themselves and of their respective data connections. **Both Modem versions shall support the following visual indicators, for both of the enclosed Modems, (Req. 10).**

- i) Transmitted Data, (TD), this shall indicate to the User the presence and logic state of the data being transmitted to the Modem.
- ii) Received Data, (RD), this shall indicate to the User the presence and logic state of the data transmitted to the DTE
- iii) Data Terminal Ready, (DTR), this shall indicate to the User that the Modem has recognised that the DTE is present and ready.
- iv) Clear To Send, (CTS), this shall indicate to the User during the signalling phase that the Modem is ready to except commands from the DTE. During the data transfer phase it shall indicate the normal operation of the CTS line as specified in CCITT Recommendation V.24.
- v) Data Set Ready, (DSR), this shall indicate to the User that the Modem is in the data transfer mode.
- vi) Ring Indicator, (RI), this shall indicate to the User that the Modem has received an Incoming Call request from the Network.
- vii) The Status Indicator, (SI), shall indicate to the User that the Modem has under gone the 'Power-up' initialisation correctly. As part of the 'Power-up' initialisation procedure, all of the above indications shall be illuminated as part of a 'Lamp Test' procedure.

2.5.3 Audible Indicators

There shall be no requirement for the Modem versions to support audible indications. These indications, in accordance to EUROCOM (D/1), shall be supported by the DTE and shall be activated in response to Line Indications transmitted to the DTE, by the Modem, during the signalling phase.

3 CCITT RECOMMENDATION V.25 BIS

3.1 General

This chapter details the interface protocols that shall be employed between the DTE and Modem so as to establish a 'dialled' connection between end users of the SYSCOM network. The interface shall be primarily based on CCITT Recommendation V.25 bis, which is relatively complex in that there are several options that can be implemented and items yet to be specified. For this reason and one of clarity and non-ambiguity the specific protocols and modifications, where necessary, to be used in this implementation have been fully specified below. In addition a reference section has been produced, (See Chapter 5) to show which parts of CCITT Recommendation V.25 bis are not required or fully implemented and which are subject to modification, so as to meet the requirements of the SYSCOM network.

3.2 Introduction

CCITT Recommendation V.25 bis provides the mechanism for setting up a connection between an automatic calling data station and an automatic answering station, both composed of a DTE and DCE, by use of the 100 series interchange circuits as defined in CCITT Recommendation V.24, over the General Switched Telephone Network, (GSTN). In this application the GSTN shall be replaced by the ZODIAC network, which conforms primarily to the requirements of EUROCOM (D/1), therefore modifications shall be made to the exact definition and implementation of CCITT Recommendation V.25 bis so as to meet the requirements of this network. The following implementation and modification details shall enable the DTE user to operate an application specific V.25 bis package or a commercially available V.25 bis package to meet these requirements. The precise operation of the implemented package shall be made known to the Modem developers to ensure correct working between the DTE and the Modem, as the Modem shall only support one of the package options.

3.3 Data Terminal Equipment

The implementation of this interface shall require that the DTE be responsible for the following:

- a) during call establishment:
 - i) for ensuring that the Modem is available for operation.
 - ii) for providing the total number to be 'dialled', including in this implementation the Mode and Precedence digits in accordance with the requirements and recommendations of EUROCOM (D/1).
 - iii) for deciding to abandon the call if it is unsuccessfully completed.
- b) after call establishment:
 - i) for controlling data transfer
 - ii) for initiating disconnect at calling and answering data stations.

3.4 Data Circuit Terminating Equipment

In this implementation of this interface the DCE shall be responsible for the following:

- a) during call establishment:
 - i) for informing the DTE that it is available for operation.
 - ii) for providing the generation and detection of CPC signalling to/from the network in accordance with the requirements and recommendations of EUROCOM (D/1).
 - iii) for informing the DTE that an incoming call signal has been received via the network.

- iv) for informing the DTE that a call establishment has failed or been abandoned.
- b) after call establishment:
 - i) for providing the correct DATA Class Application in accordance with the operating characteristics of the DTE as defined in EUROCOM (D/1).
 - ii) for informing the DTE that the present call has been disconnected.

3.5 Mode of Operation

Within CCITT Recommendation V.25 bis two modes of operation are defined for the data calling and/or answering stations as below:

- a) In 'Mode 1' the DTE shall authorise the "addressed call and/or answer using circuit 108/2", (DTR), and by means of instructions exchanged between the DTE and DCE on circuits 103, (Transmitted Data), and 104, (Received Data). Other facilities are also available in this mode which are addressed later in this working paper.
- b) In 'Mode 2' the DTE shall control the "direct call and/or answer using circuit 108/1", (CDSL), and by means of a called number pre-recorded in the DCE.

It is proposed by this working paper that 'Mode 1' be implemented as there are no plans to implement permanent storage of a number or numbers within the Modem and 'Mode 2' operation can be achieved by using the Switch Hot Line facility as provided by the network and defined in EUROCOM (D/1).

4 ADDRESSED CALL AND/OR ANSWER USING CIRCUIT 108/2

4.1 Interchange Circuits

This implementation shall use the following interchange circuits as given in Table 4.1 below:

Interchange Circuit		Direction	
Number	Name	from DCE	to DCE
103	Transmitted Data		X
104	Received Data	X	
106	Clear to Send	X	
107	Data Set Ready	X	
108/2	Data Terminal Ready		X
125	Ring Indicator	X	

Table 4.1: V.25 bis Interchange Circuits

The use of these interchange circuits shall be as described below and are only valid for the duration of the remote dialling calling and answering phases of the Modem.

4.1.1 Circuit 103 - Transmitted Data

This circuit shall be used by the DTE for the issuing of 'Commands' to the Modem during the automatic calling procedure.

4.1.2 Circuit 104 - Received Data

This circuit shall be used by the Modem for responding to the Commands from the DTE with 'Indications'.

4.1.3 Circuit 106 - Clear to Send

The Modem shall turn this circuit ON in response to the DTE turning circuit 108/2 ON.

The Modem shall turn this circuit OFF:

- i) when the CPC Ring command is detected, (i.e. connection established).
- ii) when the Modem aborts the call set-up under control of the DTE by turning Circuit 108/2 OFF.
- iii) when the Modem aborts the call set-up and the DTE responds by turning Circuit 108/2 OFF.

4.1.4 Circuit 107 - Data Set Ready

The Modem shall turn this circuit ON:

- i) at the end of the call set-up phase, (i.e. CPC TEA command sent), to indicate to the calling DTE that the data connection is established and the data transfer phase can now be entered by turning Circuit 105 ON.
- ii) on receipt of CPC Pressel-ON command, to indicate to the called DTE that the data transfer phase has been entered.

The Modem shall turn this circuit OFF:

- i) to indicate that the connection has been cleared down during the data transfer phase, (i.e. CPC EOH or Pre-Emption command is detected), or data synchronisation has been irretrievably lost, (i.e. Synchronous Modem version only)
- ii) in response to a clear request, (i.e. 'On Hook'), by the DTE turning OFF circuit 108/2.

4.1.5 Circuit 108/2 - Data Terminal Ready

The DTE shall turn this circuit ON:

- i) to enable the Modem to set-up a connection.
- ii) to indicate to the Modem that it is ready to accept an incoming call.

The DTE shall turn this circuit OFF:

- i) to instruct the Modem to clear down the connection during the data transfer phase, (i.e. 'On Hook').
- ii) to instruct the Modem to abort the call set-up procedure.
- iii) to indicate to the Modem that it has acknowledged the aborted call instigated by the Modem.

4.1.6 Circuit 125 - Ring Indicator

The Modem shall turn this circuit ON to indicate to the DTE an incoming call, (i.e. CPC Ring command detected). This incoming call shall override a call set-up request prior to seizure of the line. In support of this indication the Modem shall issue the 'Incoming Call' indication on Circuit 104, therefore the use of Circuit 125 in the DTE can be optional. If the DTE does not implement Circuit 125 and Circuit 108/2 is OFF on detection of an incoming call the Modem shall perform all the network signalling protocol prior to the transmission of the CPC CSA command, (i.e. 'Off Hook'). If the DTE does not indicate that it is ready to accept the incoming call, then the Modem on receipt of the CPC Idle command from the network, indicating connection time out expiration, shall turn OFF Circuit 125 and return to the operating state prior to the detection of the incoming call.

4.1.7 Other Interchange Circuits

The state of the other interchange circuits are not part of this signalling procedure, however to maintain compatibility with DTEs the Modem shall operate Circuit 109, (DCD), such that it follows Circuit 106. Although CCITT V.25 bis states that DTE Circuit 105, (RTS), can be ignored, as it is now used in the latter stages of the CPC signalling phase, it is recommended that it be in the OFF state until required.

4.2 Command and Indication Formats

In support of the operation of the interchange circuits 106, 107 and 108/2 during the call set-up phase, messages shall be exchanged between the DTE and Modem on Circuits 103 and 104. These messages are defined as 'Commands', DTE to DCE, and 'Indications', DCE to DTE. These Commands and Indications shall consist of a suffix accompanied with a set of parameters where necessary. The Modem shall implement the CCITT Recommendation V.25 bis Commands and Indications detailed in Table 4.2. The remaining Commands and Indications contained in CCITT Recommendation V.25 bis are not required and shall not be supported by the Modem.

Command/ Indication	ITA5 Characters	Parameter Format	C/ I
Call Request with Number	CRN	Number to be dialled CRN XXXXX...XXXXX	C
Call Request Mem AddressS	CRS	(Memory Address) CRS (XXXXXXXX)	C
INcoming Call	INC	INC	I
Call Failure Indication	CFI	Parameter CFI XX	I
VALid	VAL	VAL	I
INValid	INV	INV	I

Table 4.2: Command and Indication Format

The above Commands and Indications, as shown in Table 2, and their associated parameters are described below:

4.2.1 Call Request with Number (CRN)

This Command from the DTE shall instruct the Modem to initiate a call set-up procedure. The Command shall include the suffix CRN followed by the parameter consisting of the number to be dialled. In all cases the number shall also contain the Mode and Precedence digits as defined in EUROCOM (D/1). The Modem shall store the dialled number in temporary memory and on completion of the Command it shall proceed with the connection set-up procedure using the stored number.

4.2.2 Call Request with Memory Address (CRS)

This Command from the DTE shall instruct the Modem to initiate a Switched Hot Line call set-up procedure which does not require a dialled number to be given by the DTE. This Command shall consist of the suffix CRS and it is an application specific implementation and interpretation of the actual Command defined in CCITT Recommendation V.25 bis. If a commercial V.25 bis package is used in the implementation which requires the transmission of a Memory Address parameter, then the Modem shall accept and respond accordingly to such a Command format, however, it shall ignore the Memory Address parameter contents when proceeding with the call.

4.2.3 Incoming Call (INC)

This Indication from the Modem shall instruct the DTE that the CPC Ring command has been detected and therefore an incoming call is pending. It shall consist of the suffix INC. In the event of a collision between an incoming call and call request, the incoming call shall have priority.

4.2.4 Call Failure Indication (CFI)

This Indication shall be issued by the Modem in response to a call request to indicate the reasons for the failure of the call. It shall include the suffix CFI followed by the parameters given below:

- i) Engaged tone: This shall be given in the event of an CPC Busy command being received.
- ii) Number Unobtainable: This shall be given in the event of an CPC NU command being received.
- iii) Ring Tone: This shall be given in the event of the call establishment timer expiring.
- iv) Abort Call: This shall be given in the event that the Modem aborts the attempted call establishment.
- v) Local DCE Busy: This shall be given to indicate that the 'In/Uitboeken' procedures were successful.

4.2.5 Valid (VAL)

This Indication shall be issued by the Modem to acknowledge the Command from the DTE and to inform the acceptance of that Command. It shall consist of the suffix VAL.

4.2.6 Invalid (INV)

This Indication shall be issued by the Modem to inform the DTE that it has received an invalid Command or it is unable to execute that Command. It shall consist of the suffix INV. There shall be no parameter issued with this indication.

4.3 Format for Commands and Indications

The above Commands and Indications shall be encoded in the formats given below for transmission over Circuits 103 and 104, according to the DTE to Modem interface application.

4.3.1 Asynchronous Operation

The format for asynchronous operation shall be as shown in Figure 4.3a. In this mode of operation the character format shall be one start element followed by 8-bit data units and one-unit stop element.

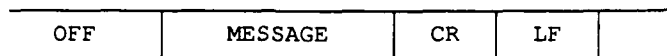


Fig. 4.3a: Asynchronous Operation

The 8-bit data units shall be formed by a 7-bit ITA 5 character in accordance with CCITT Recommendation T.50, [Ref.5], together with an even parity unit in accordance with CCITT Recommendation V.4. The use of a message end character set other than Carriage Return + Line Feed shall be indicated by the User.

4.3.2 Synchronous Operation

The format for synchronous character oriented operation shall be in accordance with ISO 1745 and shall be as shown in Figure 4.3b.

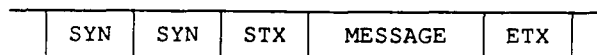


Fig. 4.3b: Synchronous Operation

In this mode the consecutive 8-bit data units shall be used and they shall be formed by a 7-bit ITA5 character in accordance with CCITT Recommendation T.50, together with an odd parity unit in accordance with CCITT Recommendation V.4.

4.4 Message Format

The message format to be used in the above modes of operation shall consist of the following:

- i) a three character Command or Indication (See Table 2).
- ii) a parameter character set made up from the alphabet in Table 4.4.

Parameter	ITA 5 Coding
0 to 9 inc	0 to 9 inc
Abort Call	AB
Local DCE Busy	CB
Engaged Tone (Busy)	ET
Number Unobtainable	NT
Ring Tone	RT

Table 4.4: Parameter Alphabet

The remaining Parameters contained in CCITT Recommendation V.25 bis are not required and shall not be supported by the Modem.

4.5 Command and Indication Exchange Protocol

The following protocol shall be followed between the DTE and Modem when exchanging Commands and Messages:

- i) Every Command shall be followed by an indication from the Modem or Circuit 107 being turned ON in the case of a successful call.
- ii) Whenever a Command or Indication is received with a parity error it shall be disregarded.
- iii) Whenever the Modem detects an error in the message field of a Command it shall acknowledge the error by issuing an Invalid Indication (INV).

4.6 Interface Procedures at the Calling Data Station

The DTE - Modem interface procedure for automatic calling and answering is shown in Figure 4.6. The call set-up procedure shall be as follows:-

When the DTE is not ready to answer an incoming call or to enter dialogue with Modem, the interface shall be in state 1, DTE not ready.

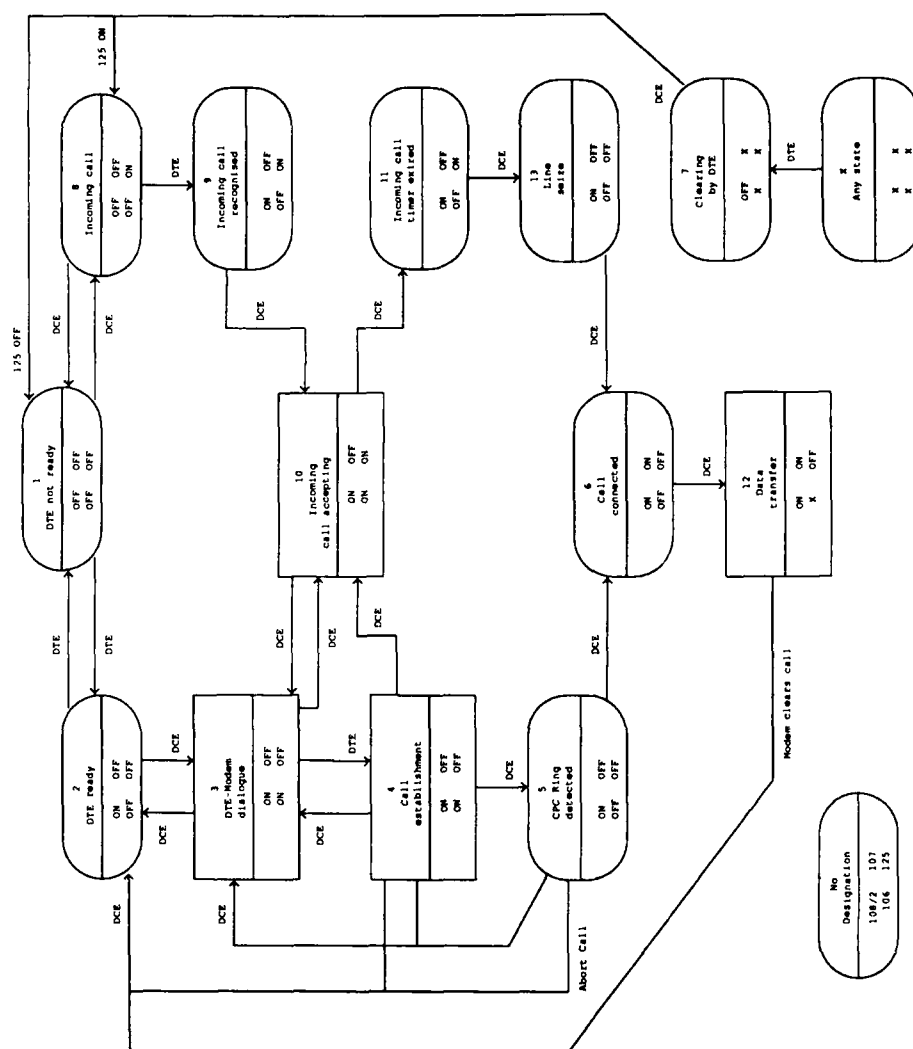


Fig. 4.6: Addressed Call 108/2 Response Mode

Prior to entering dialogue with the Modem, the DTE shall turn ON Circuit 108/2. The interface shall then be in state 2, *DTE ready*.

The Modem shall signal to the DTE that it is ready to enter dialogue with the DTE by turning ON Circuit 106, state 3, *DTE-Modem dialogue*. In this state the DTE can issue Commands and the Modem Indications.

To initiate a call set-up the DTE shall issue a Call Request Command, as detailed in Para. 4.2.1 or 4.2.2, which shall be acknowledged by the Modem with an Invalid or Valid Indication. In the latter case the interface shall move to state 4, *Call establishment*. The Modem shall remain in state 4 during the dialling process.

If the call is established, (i.e. Ring CPC command is detected), the interface moves to state 5, *CPC Ring detected*, and Circuit 106 is turned OFF.

If the call fails, the Modem shall issue a Call Failure Indication while in state 4 or state 5 and return to state 3, except in the case of an 'Abort Call' indication where it shall return to state 2 and the procedure shall be as defined in CCITT Recommendation V.24 Para. 4.4.3 for circuit 108/2.

On completion of the line procedures, (See Para. 4.8), the Modem shall turn Circuit 107 ON and the interface shall move to state 6, *Call connected*. From this state the DTE shall enter state 12, *Data transfer*.

While the Modem is in state 3 or state 4, prior to going 'Off Hook', (i.e. prior to the transmission of the CPC Seize), an incoming call shall be signalled to the DTE by turning Circuit 125 ON and the issuing of the Incoming Call Indication. The interface then moves to state 10, *Incoming call accepting*. The Modem shall then implement a call acceptance timer before proceeding to state 11, *Incoming call timer expired*.

The DTE may clear a call or call attempt at any time by turning Circuit 108/2 OFF, state 7, *Clearing by DTE*, the interface shall then move to state 1 or state 8 for Circuit 125 OFF or ON respectively.

4.7 Interface Procedures at the Answering Data Station

The DTE - Modem interface procedure for automatic calling and answering is shown in Figure 4.6. The answering procedure shall be as follows:-

When the DTE is not ready to answer an incoming call or to enter dialogue with Modem, the interface shall be in state 1, *DTE not ready*.

Prior to entering dialogue with the Modem, the DTE shall turn ON Circuit 108/2. The interface shall then be in state 2, *DTE ready*.

The Modem shall signal to the DTE that it is ready to enter dialogue with the DTE by turning ON Circuit 106, state 3, *DTE-Modem dialogue*. In this state the DTE can issue Commands and the Modem Indications.

An incoming call shall be indicated to the DTE by turning Circuit 125 ON and by the Modem issuing the Incoming Call Indication. The interface shall then move from state 3 or 4 to state 10, *Incoming call accepting*. In state 4 the incoming call shall only be detected prior to the seizure of the line.

If the incoming call occurs and the DTE is in state 1, *DTE not ready*, the Modem shall move to state 8, *Incoming call*. The DTE may then turn Circuit 108/2 ON in response to the call or to enter dialogue with the Modem. The interface shall then move to state 9, *Incoming call recognised*. The Modem shall respond by turning Circuit 106 ON and therefore the interface moves to state 10.

On expiration of the call acceptance timer the Modem shall proceed with the incoming call by moving to state 11 *Incoming call timer expired* and turning Circuit 106 OFF and then onto state 13, *Line seized*, by turning Circuit 125 OFF on detection of the CPC command CCA.

On completion of the line procedures, (See Para. 4.8), the Modem shall turn Circuit 107 ON and the interface shall move to state 6, *Call connected*. From this state the DTE shall enter state 12, *Data transfer*.

If during state 12, *Data transfer*, the Modem aborts the current call by turning Circuit 107 OFF, the Modem shall return to state 2 and then the procedure shall be as defined in CCITT V.24 para. 4.4.3 for circuit 108/2.

4.8 Line Procedures

The Modem shall perform the necessary signalling conversion between that of CCITT Recommendation V.25 bis and the requirements of the network, conforming to EUROCOM (D/1). The line procedures at the calling and answering Modem's shall be as follows.

4.8.1 Line Procedure at the Calling Modem

Whenever the Modem has received the complete Call Request Command, (i.e. including the number to be dialled in the case of CRN), it shall seize the line by transmitting the CPC Seize command. The calling procedure shall then proceed as defined in EUROCOM (D/1) and as detailed in Para. 2.3.3 of this document.

During the connection request the Modem shall monitor the network for call failure indications. On detection of a call failure indication the Modem shall issue the appropriate Call Failure Indication to the DTE. If during the connection request procedure the Modem aborts the call attempt due to a CPC signalling error or the network fails, then the Modem shall indicate such a failure by issuing an Abort Call Indication.

On detection of the CPC Ring command from the network the Modem shall turn Circuit 106 OFF.

On transmission of the CPC TEA command to the network the Modem shall turn Circuit 107 ON and then wait for the DTE to turn Circuit 105 ON. On detection of Circuit 105 being turned ON the Modem shall transmit to the network the CPC Pressel ON command followed by 64ms of V.24 quiescent line logic level. On completion of the above it shall turn Circuit 106 ON indicating to the DTE that the Data Transfer phase is complete and data may now be transmitted.

If the DTE or Modem at any time cancels the call or call request or the network fails, the Modem shall abort the connection by issuing the CPC Release command to the network.

4.8.2 Line Procedure at the Answering Modem

When the CPC Ring command is detected from the network the Modem shall turn Circuit 125 ON and if Circuits 108/2 and 106 are ON then it shall also issue an Incoming Call Indication.

If Circuit 108/2 is OFF the Modem shall halt the incoming call procedure by not issuing the CPC CSA command to the network.

If Circuit 108/2 and 106 are ON and after the incoming call accepting Timer expires the Modem shall turn Circuit 106 OFF and proceed with the connection of the incoming call.

On receipt of the CPC CCA command from the network the Modem shall turn Circuit 125 OFF.

On receipt of the CPC Pressel ON command from the network the Modem shall turn Circuit 107 ON and enter the data transfer phase.

If during the data transfer phase the Modem detects the CPC EOH or Pre-Emption commands from the network, it shall terminate the on going call by turning Circuit 107 OFF and issue the CPC Release command to the network.

4.9 Sole User Facility

It has been highlighted that there shall be a requirement for some SYSCOM end data stations to enter directly into the data transfer mode on 'Power-up' without any signalling protocol over the V.25 bis interface. This shall be achieved by using a sub-set of the Sole User/Back to Back Connection facility of the network as defined in EUROCOM (D/1). This connection facility type via the Modem shall only be available for Modem to Modem interconnectivity. For other types of interconnection, (e.g. Modem to DBT), the connection shall be achieved

by use of the Basic Connection Set-up or Switched Hot Line facilities. The identifying characteristic of this type connection facility is that, this is the only time that the Modem shall receive the CPC Release command over the network interface. Therefore the operation of the Modem shall be as follows, on detection of Circuit 108/2 being turned ON the Modem shall turn Circuit 106 ON, (i.e. DTE -Modem dialogue). On the receipt of the CPC Release command from the network the Modem shall start a 'Random Seize Timer'. If before this Timer expires the Modem detects the CPC Seize command it shall halt the Timer and proceed with the connection set-up as described below. If the Timer times out then the Modem shall transmit the CPC Seize command itself. If there is a CPC Seize command collision (i.e. both transmit and detect CPC Seize), then the Modems shall re-transmit the CPC Release command and execute the Timers again.

On detection of the CPC Seize command the Modem shall transmit the CPC CSA command and turn Circuit 106 OFF. There shall be no issuing of the Incoming Call Indication. The operation of the Modem shall then be as per the Sole User connection procedure, (i.e. lines 12 to 15), defined in EUROCOM (D/1). On detection or transmission of the CPC TEA command the Modem shall turn Circuit 107 ON and enter the data transfer phase. Note in this mode it shall not issue the CPC Pressel ON command as with the other types of connection facilities. If the call set-up or network fails there shall be no issuing of a Call Failure Indication and the Modem shall return to state 3. If the network failure recovers and the Modem again detects the CPC Release command from the network, it shall again implement the Sole User connection set-up procedure as described above.

5 CCITT RECOMMENDATION V.25 BIS REFERENCE LIST

The following is a comparison reference list between CCITT Recommendation V.25 bis and its implementation as defined in the Modem requirements specification in Chapters 3 and 4 of this report. It shows which parts of CCITT Recommendation V.25 bis are conformed to, modified or not implemented, so as to meet the SYSCOM network requirement.

5.1 CCITT Recommendation V.25 bis Chapters

Chapters 1 - 3 are primarily descriptive and are not compared however, Chapter 3 of this report is in principle the same.

Chapter 4: **Addressed Call and/or Answer Authorized by the DTE**
(Circuit 108/2)

4.1.1	Interchange Circuits Involved	CONFORMS
4.1.1.1	Circuit 103 - Transmitted Data	CONFORMS
4.1.1.2	Circuit 104 - Received Data	CONFORMS
4.1.1.3	Circuit 106 - Ready For Sending	MODIFIED (See Para. 4.1.3)
4.1.1.4	Circuit 107 - Data Set Ready	MODIFIED (See Para. 4.1.4)
4.1.1.5	Circuit 108/2 - Data Terminal Ready	MODIFIED (See Para. 4.1.5)
4.1.1.6	Circuit 125 - Ring Indicator	CONFORMS
4.1.1.7	Other Interface Circuits	MODIFIED (See Para. 4.1.7)
4.1.2	Control Information Format	CONFORMS
4.1.2.1	Call Request Commands	MODIFIED (See Para. 4.2)
4.1.2.2	Program Commands	NOT IMPLEMENTED
4.1.2.3	List Request Commands	NOT IMPLEMENTED
4.1.2.4	Disregard Incoming Call Command	NOT IMPLEMENTED
4.1.2.5	Connect Incoming Call Command	NOT IMPLEMENTED
4.1.2.6	Call Failure Indication	MODIFIED (See Para. 4.2.4)
4.1.2.7	Delay Call Indication	NOT IMPLEMENTED

4.1.2.8	Incoming Call Indication	CONFORMS
4.1.2.9	Valid Indication	CONFORMS
4.1.2.10	Invalid Indication	CONFORMS
4.1.2.11	List Indications	NOT IMPLEMENTED
4.1.2.12	Call Connecting Indication	NOT IMPLEMENTED
4.1.3	Format for Commands and Indications	CONFORMS
4.1.3.1	Asynchronous Operation	CONFORMS
4.1.3.2	Synchronous Operation	CONFORMS
4.1.3.3	Synchronous Bit Orientated Operation	NOT IMPLEMENTED
4.1.4	Message Format and Encoding	MODIFIED (See Para. 4.4)
4.1.5	Command/Indication Exchange Protocol	MODIFIED (See Para. 4.5)
4.2	Interface Procedure at the Calling Data Station	MODIFIED (See Para. 4.6)
4.3	Interface Procedure at the Answering Data Station	MODIFIED (See Para. 4.7)

**Chapter 5: Addressed Call and/or Answer Controlled by the DTE
(Circuit 108/1)**

This chapter is: NOT IMPLEMENTED

Chapter 6: Line Procedures

6.1	Line Procedure at the Calling DCE	MODIFIED (See Para. 4.8.1)
6.2	Line Procedure at the Answering DCE	MODIFIED (See Para. 4.8.2)

Chapter 7: Manual Calling and Answering

This chapter is: NOT IMPLEMENTED

Annex A: Test Facilities

This annex is: NOT IMPLEMENTED

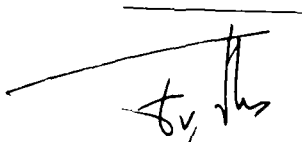
Annex B: Test Facilities

This annex is: NOT IMPLEMENTED

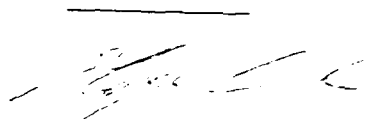
6 MODEM REQUIREMENTS CONCLUSIONS

The following list is a culmination of all the requirements made in this report with the respective paragraph reference, which if implemented in the design of the Modem shall enable it to support the operational requirements of the SYSCOM network.

Req. 1	Modem Type	Type A (See Para. 2.1)
Req. 2	Directory Dialling	EUROCOM (D/1) Chapter IA7 (See Para. 2.2)
Req. 3	Interface J Physical	CCITT Rec. V.24 and V.28 (See Para. 2.3.1)
Req. 4	Interface J Dialling	CCITT Rec. V.25 bis (See Para. 2.3.2 & Chapters 3 and 4)
Req. 8	Interface J Bit Rates	Async 300 - 2400 Baud, Sync 9.6 kbit/s (See Para. 2.4.1)
Req. 5	Interface K Physical	16 kbit/s, 2-wire, Full Duplex, CDS (See Para. 2.3.3)
Req. 6	Interface K Signalling	EUROCOM (D/1) Chapter ID3 (See Para. 2.3.3)
Req. 7	Interface K Facilities	EUROCOM (D/1) Chapter ID3 (See Para. 2.3.3)
Req. 9	DATA Class Application	EUROCOM (D/1) Chapter IA9 (See Para. 2.4.3)
Req. 10	Visual Indicators	See Para. 2.5.2

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Ir. F.G.J. van Aken
(Groupleader)

A handwritten signature in dark ink, appearing to be 'P.P. Copeland', written over a horizontal line.

P.P. Copeland
(Author)

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REPORT DOCUMENTATION PAGE

(MOD-NL)

1. DEFENSE REPORT NUMBER (MOD-NL) TD90-1234	2. RECIPIENT'S ACCESSION NUMBER	3. PERFORMING ORGANIZATION REPORT NUMBER FEL 90-A116
4. PROJECT/TASK/WORK UNIT NO.	5. CONTRACT NUMBER A87KL072	6. REPORT DATE MAY 1990
7. NUMBER OF PAGES 41	8. NUMBER OF REFERENCES 5	9. TYPE OF REPORT AND DATES COVERED FINAL
10. TITLE AND SUBTITLE DEFINITION STUDY INTO THE REQUIREMENTS OF A DATA MODEM FOR THE SYSCOM NETWORK.		
11. AUTHOR(S) F.P. COPELAND		
12. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) FEL-TNO, OUDE WAALSDORPERWEG, 63, THE HAGUE.		
13. SPONSORING/MONITORING AGENCY NAME(S) DMXL, VAN DER BURCHLAAN 31, 2597 PC, THE HAGUE.		
14. SUPPLEMENTARY NOTES -		
15. ABSTRACT (MAXIMUM 200 WORDS, 1044 POSITIONS) THIS DOCUMENT DESCRIBES THE FUNCTIONAL REQUIREMENTS THAT NEED TO BE IMPLEMENTED IN THE DEVELOPMENT OF A 'DATA MODEM' IN SUPPORT OF THE SYSCOM PROJECT. THE MODEM SHALL BE CAPABLE OF SUPPORTING THE TRANSMISSION OF DATA OVER THE RNLA'S MOBILE TACTICAL COMMUNICATIONS NETWORK (I.E. ZODIAC), WHICH OPERATES IN ACCORDANCE WITH THE REQUIREMENTS OF EUROCOM TACTICAL COMMUNICATIONS SYSTEMS (D/1)		
16. DESCRIPTORS MODEM REQUIREMENT PROTOCOLS COMMUNICATION NETWORKS		IDENTIFIERS SYSCOM EUROCOM (D/1) CCITT V.25BIS
17a. SECURITY CLASSIFICATION (OF REPORT) UNCLASSIFIED	17b. SECURITY CLASSIFICATION (OF PAGE) UNCLASSIFIED	17c. SECURITY CLASSIFICATION (OF ABSTRACT) UNCLASSIFIED
18. DISTRIBUTION/AVAILABILITY STATEMENT UNLIMITED AVAILABILITY		17d. SECURITY CLASSIFICATION (OF TITLES) UNCLASSIFIED